



US005550887A

United States Patent [19]**Schmal et al.**[11] **Patent Number:** **5,550,887**[45] **Date of Patent:** **Aug. 27, 1996**[54] **PHASE CONTRAST X-RAY MICROSCOPE**[75] Inventors: **Günter Schmal**, Göttingen; **Dietbert Rudolph**, Einbeck-Wenzen, both of Germany[73] Assignee: **Carl-Zeiss-Stiftung**, Heidenheim (Brenz), Germany[21] Appl. No.: **436,284**[22] Filed: **May 16, 1995**[30] **Foreign Application Priority Data**

Sep. 15, 1993 [DE] Germany 43 31 251.9

[51] **Int. Cl.⁶** **G21K 7/00**[52] **U.S. Cl.** **378/43; 378/145**[58] **Field of Search** 378/43, 84, 85, 378/145[56] **References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—David P. Porta[57] **ABSTRACT**

An X-ray microscope has the following features: a pulsed x-ray source that delivers an intense line radiation, an annular condenser that focuses the radiation of the X-ray source on the object to be investigated, an X-ray optics constructed as a micro zone plate that images the object with high resolution on an X-ray detector, and a phase ring positioned in the rear focal plane of the micro zone plate and applies to the zero order X-ray radiation coming from the object a phase shift, with respect to the higher order radiation deflected by the object structures, which is determined by the thickness and material of the phase ring. The phase shift amounts, for example, to 90° or 270°.

13 Claims, 1 Drawing Sheet